

# Preface

The soaring oil/gas prices and the recognition of global warming/carbon footprints have resulted in significant demands for lightweight polymeric materials in the transportation and automotive industries in addition to their widespread usage in other sectors such as construction, packaging, toys, and electronics. However, the pressure to support and validate this change (replacing conventional metallic or other materials with polymers) in terms of properties and performance is enormous. Besides, accommodating this great surge for polymers that persist in the environment for years after their disposal is challenging from both the scientific/technical and socioeconomic perspectives. This is due to the dramatic direct/indirect impacts exerted on our eco-system (e.g., Great Pacific Garbage Patch, Citarum River pollution, Yusho disease, presence of brominated compounds in new born babies, and human breast milk, etc).

This growing combination of complex problems has greatly spurred on significant research and development activities on polymeric materials, whether biodegradable, biopolymers, nanocomposites, water-soluble, or smart polymers. Coupled with socioeconomic aspects, the demand for multifunctional materials has grown rapidly. Hence, ‘multi-functionality’ has put polymer nanocomposites under the limelight. The superiority of these materials compared to their micro- or neat counterparts is often attributed to the availability of large numbers of nanoparticles with huge interfacial areas and confinement of polymer chains at the nano-level. These characteristics of the nano-reinforcements, *if fully exploited*, can impart multifunctional properties required for a spectrum of applications.

In this monograph, we provide the basics and advanced knowledge of different facets of ‘multi-functionality’ in polymer nanocomposites. Emphasis is placed on delineating the parameters and mechanisms responsible for achieving multi-functionality by giving a systematic presentation of the underlying principles. This monograph also highlights our continuous research efforts over many years on different aspects of polymer nanocomposites toward realizing multifunctional materials. It is written as a coherent entity rather than a collection of chapters on different topics. So, we have devoted considerable efforts to coordinate and connect

all the different topics in this monograph, which include a brief review of nanoparticles (Chap. 2), their surface modification techniques and incorporation into polymeric materials (Chap. 3); the importance of accurate morphological characterization (Chap. 4) and interfaces in polymer nanocomposite materials (Chap. 5); mechanical properties particularly fracture toughness (Chap. 6), thermal stability and flame response (Chaps. 7 and 8), tribological performance (Chap. 9) and other functional properties such as optical transparency, electrical conductivity, dielectric, and permeability (Chap. 10). Finally, critical ecological issues (Chap. 11) as well as applications and future prospects of these polymer nanocomposites (Chap. 12) are presented.

The book is written with enough background in each chapter to enable beginners to follow easily the concepts presented and discussed. Our primary readership will come from the general fields of polymer science and engineering, polymer composites, nanotechnology and related disciplines. It will serve as a reference book for both undergraduate and/or postgraduate courses in polymers, composites and nanotechnology. We hope that the technical professions from the transportation, building and construction, automotive and other industries will also find the results contained in this monograph useful.

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Towards Multi-Functionality

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